Center Innovation Fund: SSC CIF

Hot Hydrogen Heat Source Development

Completed Technology Project (2014 - 2014)

Project Introduction

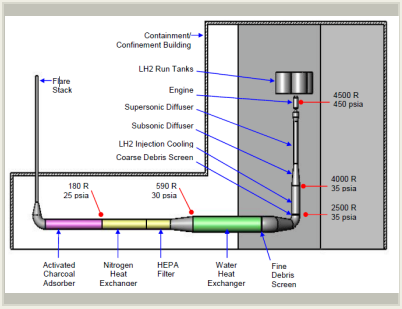
The purpose of this project is to develop a hot hydrogen heat source that would produce a high temperature hydrogen flow which would be comparable to that produced by the Nuclear Thermal Propulsion (NTP) engine, without actually using a nuclear engine, in order to simulate nuclear rocket engine exhaust temperatures (between 3,000 to 5,000 °F). Therefore, the goal of this study is to conduct a site assessment, and evaluate the potential development of ground testing facility (GTF) of non-nuclear thermal propulsion (NNTP) sub-scale rocket engine at Stennis Space Center (SSC). The facility system requirements and configuration are in the conceptual stage; however, the basic facility characteristics and overarching technology development needs for a GTF will be defined.

The proposed project technology need is evaluating the potential development to provide a capability that will produce high temperature hydrogen, in excess of 2500 Rankine (~2000°F) at a flowrate as high as 5 lb/sec to simulate a nuclear thermal propulsion (NTP) engine exhaust stream without use of a nuclear reactor as a heat source. Preliminary investigations indicate that the two most feasible options relative to system development and test operations cost are as follows: (1) develop a specific purpose heat exchanger or (2) utilize an existing hot gas generator (GG) fixture presently stored in SSC's component warehouse to heat ambient temperature gaseous hydrogen for test use.

Anticipated Benefits

The development of a technology that could generate a hot hydrogen heat source would directly benefit the NASA manned mission to Mars by creating a capability to create a source for heating hydrogen to simulate NTP engine exhaust that could enable non-nuclear rocket engine testing in a ground testing environment. Non-nuclear testing can be used to augment and facilitate system design and development as well as reduce the potential risks and costs associated with any actual future nuclear testing, system design and development.

Developing a hot hydrogen heat source capability would directly benefit NASA unfunded missions and planned missions by providing a mechanism to create a non-nuclear heat source for heating hydrogen to simulate NTP engine exhaust during ground testing. This will aid in the development of NNTP test facilities that would enable SSC to support ongoing NTP technology development at NASA/Marshall Space Flight Center and NASA/Glenn Research Center associated with the Nuclear Cryogenic Propulsion Stage (NCPS) funded through the NASA Advance Exploration Systems (AES) program, (involved in pioneering new approaches for rapidly developing prototype systems) which are being conducted in preparation for future planned manned missions to Mars.



NTP Ground Test Facility Concept

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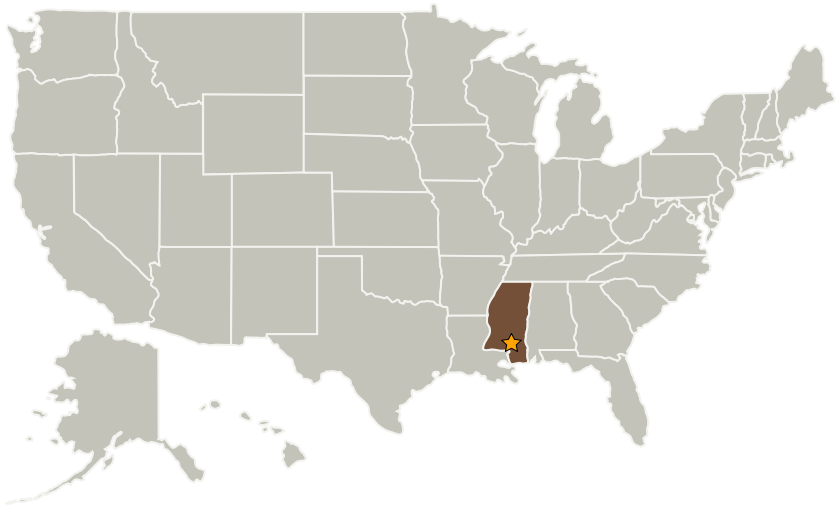
Benefits to the commercial space industry would be similar to those that benefit NASA. As commercial space based industry development continues, capabilities to further advance the safest, most cost effective means to travel into and through space are required. Utilizing novel testing capabilities developed by NASA can help facilitate these developments.

Benefits to other government agencies would be similar to those that benefit NASA. By enabling a non-nuclear method to simulate nuclear rocket engine testing, capabilities that affect design, development and system operation where nuclear exhaust is generated could be used by the Army, Navy, Department of Energy (DOE), Nuclear Regulatory Committee (NRC) and Idaho National Labs (INL).

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Stennis Space Center(SSC)	Lead Organization	NASA Center	Stennis Space Center, Mississippi

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Stennis Space Center (SSC)

Responsible Program:

Center Innovation Fund: SSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Ramona E Travis

Project Manager:

David J Coote

Principal Investigator:

David J Coote

Co-Investigator:

Richard F Wear

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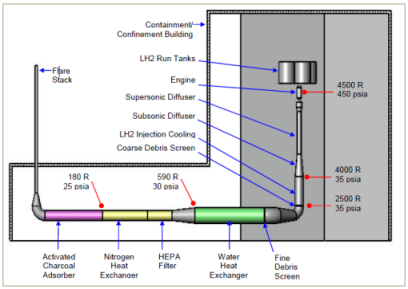
Primary U.S. Work Locations

Mississippi

Images

Hot Gas Generator in SSC Warehouse
Hot Gas Generator in SSC Warehouse
(https://techport.nasa.gov/image/2784)



NTP Ground Test Facility Concept
NTP Ground Test Facility Concept
(https://techport.nasa.gov/image/2783)

Stories

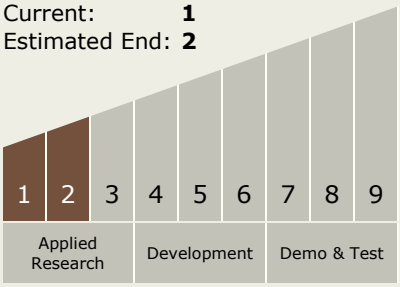
Numerical Simulation of Thermal-Hydrodynamic Transients in the Cooling Channels of a Nuclear Thermal Propulsion Engine
(https://techport.nasa.gov/file/21921)

PREDICTION OF ABLATION RATES FROM SOLID SURFACES EXPOSED TO HIGH TEMPERATURE GAS FLOW
(https://techport.nasa.gov/file/21919)

REVIEW OF NUCLEAR THERMAL PROPULSION GROUND TEST OPTIONS
(https://techport.nasa.gov/file/21940)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.2 Heat Sources